

WHAT IS CLAIMED IS:

1. An apparatus for decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including  
5 a first portion and a second portion, the apparatus comprising:

an arithmetic operation unit configured to calculate a first exclusive OR of the Reed-Muller code and an exclusive Ored value of a candidate pattern of  
10 the mask symbols and the information data corresponding to the candidate pattern;

a first decoder configured to calculate a checksum of the first exclusive OR and majority-decide the checksum to decode a part of the second portion of the  
15 information data corresponding to the orthogonal codes;

a second decoder configured to calculate a second exclusive OR of the first exclusive OR and a product of the part of the second portion of the information data and the orthogonal codes and majority-decide the second  
20 exclusive OR to decode a remaining part of the second portion of the information data corresponding to the orthogonal codes;

a Reed-Muller encoder configured to Reed-Muller encode the second portion of the information data  
25 output from the first decoder and the second decoder and the first portion of the information data;

a minimum distance detector configured to detect

the minimum of a Euclidean distance between an output  
from the Reed-Muller encoder and the Reed-Muller code  
supplied to the arithmetic operation unit while a  
plurality of candidate patterns of the mask symbols are  
5 supplied to the arithmetic operation unit,

whereby the first portion of the information data  
is decoded based on the mask symbols corresponding to  
the minimum of the Euclidean distance.

2. The apparatus according to claim 1, further  
10 comprising a memory configured to store a plurality  
of exclusive ORed value of a plurality of candidate  
patterns of the mask symbols and a plurality of  
information data corresponding to the candidate  
patterns, and wherein the arithmetic operation unit  
15 calculates the first exclusive OR of the Reed-Muller  
codes and each of the plurality of exclusive ORed  
values stored in the memory.

3. The apparatus according to claim 1, further  
comprising a hard decision unit configured to hard-  
20 decide the Reed-Muller code supplied to the arithmetic  
operation unit.

4. The apparatus according to claim 1, wherein  
the first decoder comprises:

a memory configured to store the first exclusive  
25 OR output from the arithmetic operation unit;

a checksum calculator configured to read bit data  
from the memory and calculate a plurality of exclusive

ORs of a plurality of sets of the read bit data to obtain a plurality of checksums;

a selector configured to select some of the plurality of checksums based on a type of the

5 Reed-Muller code;

an accumulator configured to accumulate the selected checksums; and

a hard decision unit configured to hard-decide an output from the accumulator.

10 5. A method of decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the method comprising:

15 calculating a first exclusive OR of the Reed-Muller code and an exclusive ORed value of a candidate pattern of the mask symbols and the information data corresponding to the candidate pattern;

20 calculating a checksum of the first exclusive OR and majority-judging the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;

25 calculating a second exclusive OR of the first exclusive OR and a product of the part of the second portion of the information data and the orthogonal codes and majority-judging the second exclusive OR to decode a remaining part of the second portion of the

information data corresponding to the orthogonal codes;

Reed-Muller encoding the decoded second portion of the information data and the first portion of the information data; and

5        detecting the minimum of a Euclidean distance between the Reed-Muller encoded data and an input Reed-Muller code while a plurality of first exclusive ORs are calculated, whereby the first portion of the information data is decoded based on the mask symbols  
10        corresponding to the minimum of the Euclidean distance.

6. An apparatus for decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the apparatus  
15        comprising:

      a first arithmetic operation unit configured to calculate an exclusive OR of the Reed-Muller code and an exclusive ORed value of a candidate pattern of the mask symbols and the information data corresponding to  
20        the candidate pattern;

      a decoder configured to calculate a checksum of the exclusive OR and majority-decide the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;

25        a second arithmetic operation unit configured to calculate a first accumulation result of each bit of a product of an output from the decoder and the

orthogonal codes and a second accumulation result of each inverted bit of a product of the output from the decoder and the orthogonal codes and detect one of the first accumulation result and the second accumulation  
5 result which corresponds to a smaller Euclidean distance between the Reed-Muller code input to the first arithmetic operation unit and encoded data of decoded data;

a minimum detector configured to detect the  
10 minimum of an output from the second arithmetic operation unit while a plurality of candidate patterns of the mask symbols are supplied to the first arithmetic operation unit,

whereby the first portion of the information data  
15 is decoded based on the mask symbols corresponding to the minimum of the output from the second arithmetic operation unit.

7. The apparatus according to claim 6, further comprising a memory configured to store a plurality  
20 of exclusive ORed value of a plurality of candidate patterns of the mask symbols and a plurality of information data corresponding to the candidate patterns, and wherein the first arithmetic operation unit calculates the exclusive OR of the Reed-Muller  
25 codes and each of the plurality of exclusive ORed values stored in the memory.

8. The apparatus according to claim 6, further

comprising a hard decision unit configured to hard-decide the Reed-Muller code supplied to the first arithmetic operation unit.

5        9. The apparatus according to claim 6, wherein the decoder comprises:

        a memory configured to store the exclusive OR output from the first arithmetic operation unit;

10        a checksum calculator configured to read bit data from the memory and calculate a plurality of exclusive ORs of a plurality of sets of the read bit data to obtain a plurality of checksums;

        a selector configured to select some of the plurality of checksums based on a type of the Reed-Muller code;

15        an accumulator configured to accumulate the selected checksums; and

        a hard decision unit configured to hard-decide an output from the accumulator.

20        10. A method of decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the method comprising:

25        calculating an exclusive OR of the Reed-Muller code and an exclusive ORed value of a candidate pattern of the mask symbols and the information data corresponding to the candidate pattern;

calculating a checksum of the exclusive OR and majority-decide the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;

5           calculating a first accumulation result of each bit of a product of decoded data and the orthogonal codes and a second accumulation result of each inverted bit of a product of the decoded data and the orthogonal codes and detect one of the first accumulation result  
10           and the second accumulation result which corresponds to a smaller Euclidean distance between the input Reed-Muller code and encoded data of the decoded data;

          detecting the minimum of one of the first accumulation result and the second accumulation result  
15           which has a smaller Euclidean distance between the input Reed-Muller code and encoded data of the decoded data while calculating the exclusive OR of the Reed-Muller code and an exclusive ORed value of each of a plurality of candidate patterns of the mask symbols  
20           and the information data corresponding to the candidate pattern,

          whereby the first portion of the information data is decoded based on the mask symbols corresponding to the minimum of one of the first accumulation result and  
25           the second accumulation result which has a smaller Euclidean distance between the input Reed-Muller code and encoded data of the decoded data.

11. An apparatus for decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the apparatus comprising:

an arithmetic operation unit configured to calculate a first product of the Reed-Muller code and an exclusive Ored value of a candidate pattern of the mask symbols and the information data corresponding to the candidate pattern;

a first decoder configured to calculate a checksum of the first product and majority-decide the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;

a second decoder configured to calculate a second product of the first product and a product of the part of the second portion of the information data and the orthogonal codes and majority-decides the second product to decode a remaining part of the second portion of the information data corresponding to the orthogonal codes;

a Reed-Muller encoder configured to Reed-Muller encode the second portion of the information data output from the first decoder and the second decoder and the first portion of the information data;

a maximum correlation detector configured to detect the maximum of a correlation between an output



from the Reed-Muller encoder and the Reed-Muller code supplied to the arithmetic operation unit while a plurality of candidate patterns of the mask symbols are supplied to the arithmetic operation unit,

5           whereby the first portion of the information data is decoded based on the mask symbols corresponding to the maximum of the correlation.

10           12. The apparatus according to claim 11, further comprising a memory configured to store a plurality of exclusive ORed value of a plurality of candidate patterns of the mask symbols and a plurality of information data corresponding to the candidate patterns, and wherein the arithmetic operation unit calculates the first product of the Reed-Muller code  
15           and each of the plurality of exclusive ORed values stored in the memory.

13. The apparatus according to claim 11, wherein the first decoder comprises:

          a memory configured to store the first product;  
20           a checksum calculator configured to read bit data from the memory and calculate a plurality of exclusive ORs of a plurality of sets of the read bit data to obtain a plurality of checksums;

          a selector configured to select some of the  
25           plurality of checksums based on a type of the Reed-Muller code; and

          an accumulator configured to accumulate the

selected checksums.

14. A method of decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including  
5 a first portion and a second portion, the method comprising:

calculating a first product of the Reed-Muller code and an exclusive ORed value of a candidate pattern of the mask symbols and the information data  
10 corresponding to the candidate pattern;

calculating a checksum of the first product and majority-decide the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;

15 calculating a second product of the first product and a product of the part of the second portion of the information data and the orthogonal codes and majority-decides the second product to decode a remaining part of the second portion of the information data  
20 corresponding to the orthogonal codes;

Reed-Muller encoding the second portion of the information data and the first portion of the information data;

detecting the maximum of a correlation between the  
25 Reed-Muller encoded data and an input Reed-Muller code while a plurality of first products are calculated, whereby the first portion of the information data is

decoded based on the mask symbols corresponding to the maximum of the correlation.

15. An apparatus for decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including  
5 a first portion and a second portion, the apparatus comprising:

10 a first arithmetic operation unit configured to calculate a first product of the Reed-Muller code and an exclusive Ored value of a candidate pattern of the mask symbols and the information data corresponding to the candidate pattern;

15 a decoder configured to calculate a checksum of the first product and majority-decide the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;

20 a second arithmetic operation unit configured to calculate a first accumulation result of each bit of a product of an output from the decoder and the orthogonal codes and a second accumulation result of each inverted bit of a product of the output from the decoder and the orthogonal codes and detect a larger one of the first accumulation result and the second accumulation result;

25 a maximum detector configured to detect the maximum of an output from the second arithmetic operation unit while a plurality of candidate patterns

of the mask symbols are supplied to the first arithmetic operation unit,

whereby the first portion of the information data is decoded based on the mask symbols corresponding to the maximum of the output from the second arithmetic operation unit.

16. The apparatus according to claim 15, further comprising a memory configured to store a plurality of exclusive ORed value of a plurality of candidate patterns of the mask symbols and a plurality of information data corresponding to the candidate patterns, and wherein the first arithmetic operation unit calculates the first product of the Reed-Muller code and each of the plurality of exclusive ORed values stored in the memory.

17. The apparatus according to claim 15, wherein the decoder comprises:

a memory configured to store the first product;  
a checksum calculator configured to read bit data from the memory and calculate a plurality of exclusive ORs of a plurality of sets of the read bit data to obtain a plurality of checksums;

a selector configured to select some of the plurality of checksums based on a type of the Reed-Muller code; and

an accumulator configured to accumulate the selected checksums.

18. A method of decoding Reed-Muller code in which information data is encoded by using mask symbols and orthogonal codes, the information data including a first portion and a second portion, the method comprising:

calculating a first product of the Reed-Muller code and an exclusive ORed value of a candidate pattern of the mask symbols and the information data corresponding to the candidate pattern;

calculating a checksum of the first product and majority-decide the checksum to decode a part of the second portion of the information data corresponding to the orthogonal codes;

calculating a first accumulation result of each bit of a product of decoded data and the orthogonal codes, and a second accumulation result of each inverted bit of a product of the decoded data and the orthogonal codes and detect a larger one of the first accumulation result and the second accumulation result;

detecting the maximum of the first accumulation result and the second accumulation result while calculating the first product of the Reed-Muller code and an exclusive ORed value of each of a plurality of candidate patterns of the mask symbols and the information data corresponding to the candidate pattern,

whereby the first portion of the information data

